



## Math-Based Decisions in Air Traffic Control

### Student Workbook A

- Introduction to Real Air Traffic Control
  - Units
  - Sector Display
  - Sector Information
  - Spacing Information



Planes use nautical miles to measure distance and speed.

Investigator: \_\_\_\_\_

**An Airspace Systems  
Program Product**



## Understand Sector Information



Investigator: \_\_\_\_\_

### Understand Units

Distance:

Travel on land is measured in Statute Miles - commonly called "miles".

Travel in the air and on the sea is measured in **Nautical Miles (Nmiles)**.  
A nautical mile is a little *longer* than a statute mile.

$$1 \text{ nautical mile} = 1.15 \text{ statute miles}$$

A Nautical Mile is a little longer than a statute mile.



Speed:

Speed on land is measured in Miles per Hour (mph).

Speed in the air and on the sea is measured in Nautical Miles per Hour - commonly called "**knots**" (Kts).

$$1 \text{ "knot"} = 1 \text{ nautical mile per hour}$$

Just as a Nautical Mile is a little *longer* than a Statute Mile, 1 Knot (nautical mile per hour) is a little *faster* than 1 mile per hour.

### Understand the Sector Display

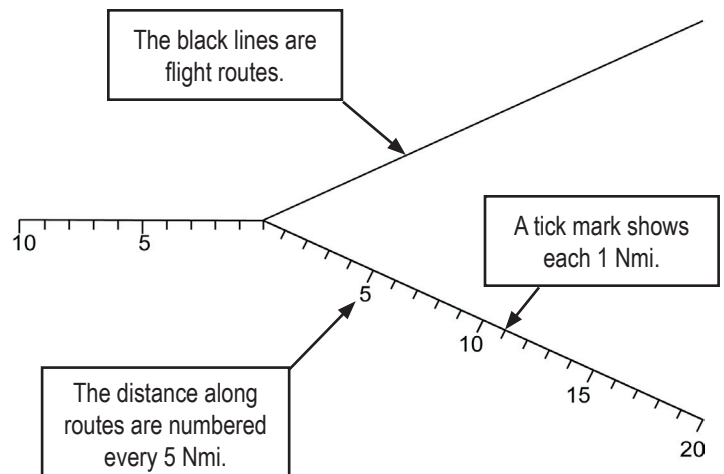
A **Sector** is the air space above a specific geographical section of the country.

Each sector has 2 air traffic controllers. They are responsible for the safe and efficient flight of all aircraft in that sector.

A sector is composed of many interconnected **Routes**. Routes are invisible pathways in the sky.

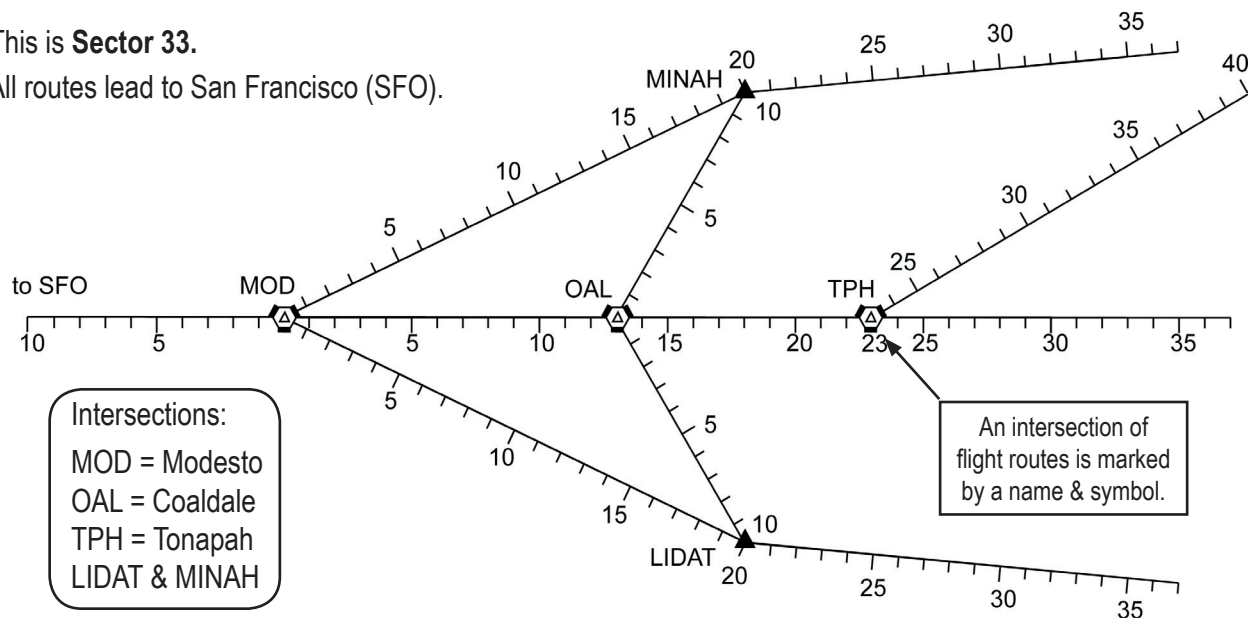
When you look at an air traffic problem display, you will see:

- > Lines to show the routes
- > Numbers at each 5 Nmiles distance
- > Tick marks at each 1 Nmiles distance



## Understand Sector Information (Continued)

- ✎ This is **Sector 33**.
- ✎ All routes lead to San Francisco (SFO).



- ✎ Sector 33 is a real sector in northern California. But we've used different distances.
- ✎ Sector 33 controllers merge traffic onto a single route at MOD.

It is important that you understand the distances between intersections.

1

Circle the intersections at MOD and MINAH.

2

What is the direct distance from:

	MINAH	TPH	LIDAT
To MOD?	<input type="text"/> Nmi	<input type="text"/> Nmi	<input type="text"/> Nmi
To OAL?	<input type="text"/> Nmi	<input type="text"/> Nmi	<input type="text"/> Nmi

Where is MOD?



3

How far is it from MINAH to OAL to MOD?

nautical miles.

4

How far is it from MINAH to MOD directly?

nautical miles.

5

How much shorter is it to go from MINAH to MOD directly rather than by way of OAL?

nautical miles.

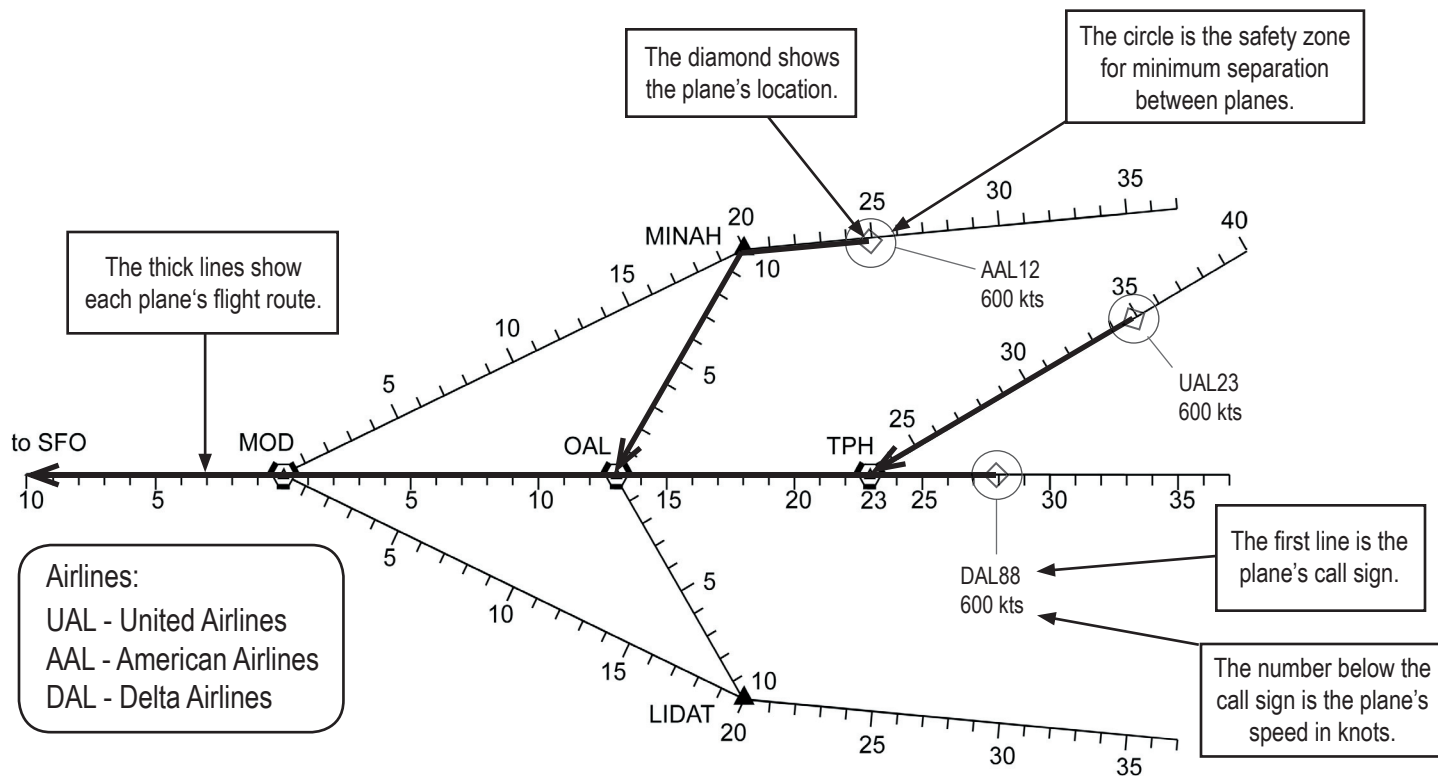
6

How much further is it to go from LIDAT to MOD by way of OAL rather than directly?

nautical miles.

## Understand Sector Information (Continued)

- Information for each plane, including its position, is shown on the sector display.



7

Circle the diamond for the Delta Airlines flight on the sector display.

8

What is the speed of the Delta Airlines flight?  knots.

A **Flight Plan** is a plane's route of travel from intersection to intersection, including speed (knots) and altitude. In our case, the altitude will be the same for all planes.

9

Locate flight AAL12 and write the intersections (in order) for its flight plan to San Francisco (SFO):

To:

Then to:

Then to:

10

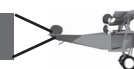
What is the length of the flight route of AAL12 from its current position to MOD?

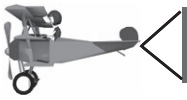
Nmiles

11

What is the length of the flight route of UAL23 from its current position to MOD?

Nmiles





# Understand Airplane Spacing Requirements



Investigator: \_\_\_\_\_



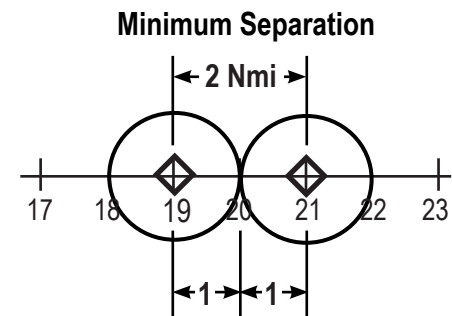
The **Objective** of air traffic control is to **safely** and **efficiently** move planes to their destinations.

## Safety - Minimum Separation

To be **safe**, planes must **always** be kept far enough apart that collisions and near-misses **NEVER** happen.

- ✎ The Federal Aviation Administration has established the least distance allowed between planes. This is called the **Minimum Separation**.

You will use **Minimum Separation = 2 Nmiles**



- ✎ On air traffic control displays, this minimum separation is shown by a “safety circle” around the plane symbol. The circle radius is 1 Nmile.
- ✎ When two circles just touch, the distance between the planes is 1 Nmi + 1 Nmi = 2 Nmi, the minimum separation.

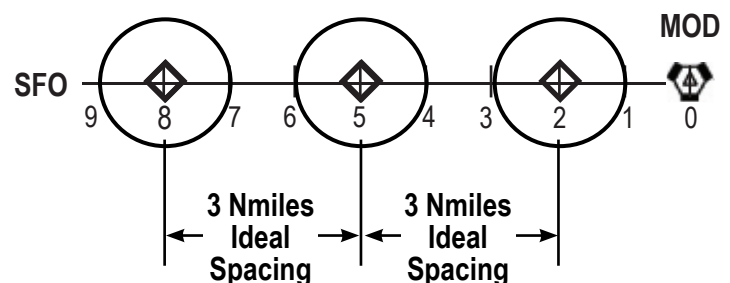
To be safe, the circles must **NEVER** overlap.



## Efficiency - Ideal Spacing

- ✎ At SFO, planes arrive from Sector 33 and from other sectors. So, at MOD the Sector 33 controllers must leave more than 2 Nmi to let planes from other sectors merge after MOD.
- ✎ This greater spacing is referred to as **Ideal Spacing**.

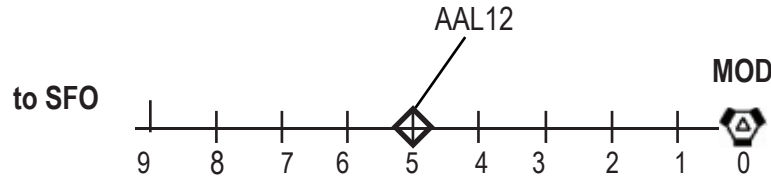
**Ideal Spacing at MOD = 3 Nmiles**



- ✎ You must aim for Ideal Spacing at MOD. Everywhere else you need at least Minimum Separation.

## Understand Airplane Spacing Requirements (Continued)

- 1 What is the Minimum Separation requirement? ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Nmiles
- 2 What is the Ideal Spacing? ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Nmiles
- 3 On the plot below, AAL12 is flying from MOD to SFO. Using the Minimum Separation, draw a “safety circle” around the flight symbol for this flight.



- 4 UAL74 is **following** AAL12 to SFO. On the route, draw a diamond to show UAL74 at the Minimum Separation.
- 5 Draw a “safety circle” around the diamond for UAL74.
- 6 DAL88 is **ahead** of AAL12 to SFO. On the route, draw a diamond and a safety circle to show DAL88 at the Ideal Spacing.
- 7 In each diagram, check all boxes that are **true**.

